State of Wisconsin

CORRESPONDENCE/MEMORANDUM

DATE: February 18, 2003 FILE REF:

TO: Air Toxics Monitoring File

FROM: David Grande – AM/7
Mark K. Allen – AM/7

SUBJECT: Ambient Mercury Monitoring Near Vulcan Materials Company, Port Edwards, April 8 – May 16, 2002 and August 16 – September 27, 2002

Project Overview

The Wisconsin DNR shares the use of a trailer equipped with mercury and meteorological equipment with the states of Michigan and Minnesota. Possession of this instrumentation was obtained in early March of 2002, and continued through the end of May. During this period, the two Tekran mercury analyzers were operated first next to each other, to ensure that they were operating properly, and then each analyzer was deployed to a location anticipated to have high ambient levels of mercury. One of these locations was at Vulcan Materials Company in Port Edwards, Wisconsin.

In addition to this initial period, a single Tekran was available to Wisconsin in the months of August and September, during which time it was located at Vulcan. The second visit was in part to correct problems associated with the first visit. Of particular importance was the incorporation of a smaller sample volume, thereby allowing high concentrations to be accurately quantified without overloading the instrument.

Vulcan Materials Company produces chlorine using the chlor-alkali process, which requires the use of large quantities of mercury as a catalyst. While technically mercury is not consumed in the process, conditions allow for the evaporation of significant quantities, much of which escapes as fugitive emissions. Estimated mercury emissions reported to the DNR range from about 1081 to 1110 pounds per year between 1996 and 2000. This represents the largest single source of mercury to the atmosphere in Wisconsin, approximately 20% of the total reported emissions statewide.

The facility agreed to host a monitoring trailer, not only providing a secure location, but also power for operations. The trailer was parked across Highway 73 to the east of the facility, in an auxiliary parking lot for employees between April 8 and May 16, 2002. Technical difficulties with the instrument required its removal for maintenance between April 19 and 26, 2002. The sampler was located at Vulcan again between August 16 and September 27, 2002. No problems were encountered during the second monitoring period.

Equipment and Methodology

Mercury measurements were obtained through the use of a Tekran 2537A Mercury Vapour Analyzer. This instrument collects mercury by drawing ambient air through a cartridge containing a gold adsorbent. The collected mercury is then thermally desorbed and detected using Cold Vapour Atomic Fluorescence Spectrometry (CVAFS). The use of two adsorbent cartridges in parallel allows for continuous sampling of ambient air.

The sampling cycle consists of drawing ambient air over the adsorbent cartridge for 5 minutes, after which a valve switches the sample flow to the second cartridge. The first cartridge is then flushed to remove any unabsorbed mercury in the cartridge and airways, after which it is heated to drive off the mercury and send it to the detector. This protocol therefore provides 5 minute average concentrations.

An internal Mercury permeation source allows for a daily calibration cycle. The calibration cycle includes a cleaning cycle intended to remove any residual mercury on the cartridges; zero determinations during which clean cylinder air is sampled for the same period as ambient determinations; and span determinations during which air is sampled from over the permeation source. The instrument performs another cleaning cycle before returning to ambient air sampling. The calibration cycle takes 40 minutes to perform in its entirety.

Instrument performance is monitored by the response during the clean and zero cycles, and the changes in the response factor calculated from the span values. Major residual concentrations in the zero or clean cycles may be an indicator of instrumental contamination requiring action. Sudden major changes in a response factor, or major differences between the two channels may also be indications of instrumental malfunctions.

In addition to the automatic internal calibration, manual calibration checks can be performed. Ideally, this is accomplished by switching the zero cylinder air and ambient sample lines, therefore providing a clean baseline response, and injecting known quantities of mercury vapor during the sampling cycle. The known quantities of mercury vapor are provided by a mercury source, which contains a small quantity of elemental mercury held at a constant temperature in a closed space. A syringe is used to extract an aliquot of air from the device, and vapor pressure calculations used to quantify the amount of mercury injected into the analyzer.

Manual calibration checks were performed as described several times throughout the monitoring period. The general rule for acceptable results from this check is ± 20% of the calculated value. A summary of internal calibrations and manual calibration checks is included in the Quality Control Data section. Calculations used for this procedure are included in Appendix A: Verification Protocols following the main body of this report.

Meteorological data for the first part of the project was collected at an existing DNR facility near Rome, Wisconsin about six miles away. This facility collects data as part of the annual fire watch, rather than as an air monitoring effort, and is collected at a lower resolution than optimal. Data reported includes wind speed and wind direction collected on an hourly basis, with each hour averaged to the nearest 45^{o} wind direction. All data was obtained from this site after this portion of the project was completed.

One of the problems with analyzing the data from the first visit is trying to correlate 5-minute mercury averages with hourly average meteorological data, especially data limited to a 45^{o} resolution. Portable met gear was installed at the site and set for 5-minute average determinations of meteorological parameters for the second monitoring period in August and September. Wind direction was recorded on a degree basis. This increase in resolution of the data aids interpretation greatly.

All data for the project was routinely downloaded from the trailer computer and stored in computers at the DNR's central office. The data was imported to database and spreadsheet formats for processing and analysis.

Ambient Data, Mercury Results

Data from each monitoring period is considered separately, for reasons discussed below. The 5-minute average values are consolidated to provide overall, as well as hourly and daily averages. The first table below presents the overall average, maximum and minimum values observed. The second table presents the hourly values, while the third table presents the daily values. It should be noted that the "Count" values represent the number of 5-minute averages incorporated into each of the calculations. All hours and days with less than 75% completeness have been disregarded in tables R-2 and R-3, thus resulting in reduced counts. Data was not disregarded in these tables for any other reason.

It is important to notice that the minimum 5-minute average values observed during both portions of the monitoring were zero. This is highly unusual, as there is the generally recognized global background value observed in remote regions is around 1.5 ng/m^3 , a value well above the minimum detection limit of the instrument. In addition to the zero values, a total of 33 values less than 1.5 ng/m^3 were observed over the course of the project. Further discussion on this topic is included the Conclusions section of this report.

Table R-1: Summation of 5 Minute Average Values

Period	Average	Max	Min	Count
April/May	51.4	2638	0.0	8591
August/Sept	60.4	3047	0.0	11735

Table R-2: Summation of Hourly Average Values

Period	Average	Max	Min	Hours	Count
April/May	50.8	2102.9	2.2	701	8399
August/Sept	60.8	1003.6	2.8	960	11479

Table R-3: Summation of Daily Average Values

Period	Average	Max	Min	Days	Count
April/May	44.0	394.6	4.3	29	8132
August/Sept	61.0	277.8	7.8	41	11498

Ambient Data, Meteorological Evaluation

Meteorological data was incorporated to evaluate the differences between winds coming from the facility and those coming from elsewhere. The facility was directly west (270^{o}) of the monitoring trailer, covering an arc of about 90 – 100^{o} from that location. Tables R-4 and R-5 present a meteorological evaluation of the data. The tables present data evaluated on a cardinal direction basis, with each octant based on $\pm 22.5^{o}$ of the true direction. For example, the octant labeled "northeast" incorporates all values observed when the winds were between 22.5^{o} and 67.5^{0}. Raw data obtained from the Rome Fire Tower for the April/May period were already in this form, while the August/September values are vector means calculated from the 5-minute average data.

Note that hourly average mercury concentrations are used in Table R-4, to align more realistically with the hourly average wind data. Table R-5, from the August/September monitoring period, uses the 5-minute average mercury and meteorological values available. Comparisons between the two tables are facilitated by the percentages reported on the table. Note also that the total number of values with both wind and mercury data may not equal the total number of mercury observations reported above.

In addition to including the average, maximum and minimum observed from each direction, the number of hourly values observed and the percentage of the total hourly values from each direction are included. The second portion of the table tallies the number of values occurring in different data ranges. Finally, a percentage of the total values in each of the data ranges is provided (thus, 2.6% of all values observed in April and May were greater than 200 and less than 500 ng/m^3).

Table R-4: Evaluation of Results by Wind Direction, April/May Monitoring Period

Octant	Average	Max	Min	Count	Sector %	>500	>200	>100	>50	>25	<25	Total
North	15.6	129.9	2.2	83	11.2%	0	0	1	3	9	70	83
NorthEast	13.2	57.9	2.4	49	6.6%	0	0	0	2	3	44	49
East	11.7	78.8	2.4	108	14.6%	0	0	0	2	9	97	108
SouthEast	15.9	55.8	3.8	99	13.4%	0	0	0	5	15	79	99
South	28.4	1268.0	3.2	117	15.8%	1	0	2	4	14	96	117
SouthWest	122.5	2253.2	4.6	72	9.7%	3	4	6	14	7	38	72
West	175.3	1536.8	2.6	99	13.4%	12	10	17	18	11	31	99
NorthWest	41.6	552.0	2.2	113	15.3%	1	5	6	8	15	78	113
All	52.7	2252.2	2.2	740	100.0%	17	19	32	56	83	533	740
Percentage of Total Hourly Observations						2.3%	2.6%	4.3%	7.6%	11.2%	72.0%	100.0%

Table R-5: Evaluation of Results by Wind Direction, September/October Monitoring Period

Octant	Average	Max	Min	Count	Sector %	>500	>200	>100	>50	>25	<25	Totals
North	20.7	695.1	2.5	1538	14.9%	1	2	33	89	216	1197	1538
NorthEast	24.1	271.3	3.3	905	8.8%	0	1	6	77	255	566	905
East	17.9	450.2	3.5	1173	11.4%	0	1	8	38	206	920	1173
SouthEast	16.5	313.8	3.0	1548	15.0%	0	4	15	38	190	1301	1548
South	35.3	765.4	3.1	2365	23.0%	1	43	112	252	562	1395	2365
SouthWest	275.5	3047	7.2	648	6.3%	117	170	120	81	103	57	648
West	248.9	1657	1.8	665	6.5%	89	187	185	112	62	30	665
NorthWest	34.4	573.3	2.0	1454	14.1%	2	25	65	173	306	883	1454
All	84.1	3047	1.8	10296	100.0%	210	433	544	860	1900	6349	10296
Percentage of Total Observations						2.0%	4.2%	5.3%	8.4%	18.5%	61.7%	100.0%

This information is shown graphically in figures 1 and 2 on the following page, which illustrate the concentration versus the wind direction in each respective monitoring period. Values plotted in Figure 1 are the hourly average ambient observations calculated from the April/May monitoring period. Note that the concentrations are plotted versus wind quadrant, while the August/September graph is versus wind direction. The raw 5-minute average values are used in Figure 2. Both the numerical and graphical representations indicate a clear influence of Vulcan Materials on local ambient mercury concentrations.

Figure 1: Ambient Hourly Mercury Concentration versus Wind Octant, April/May

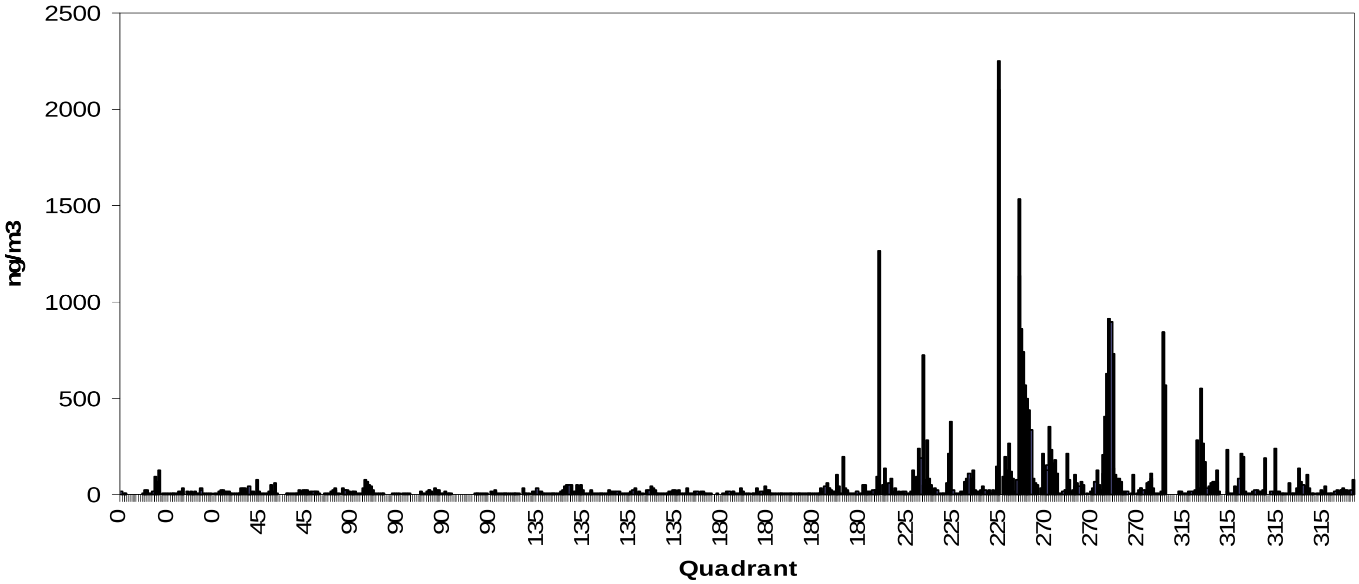
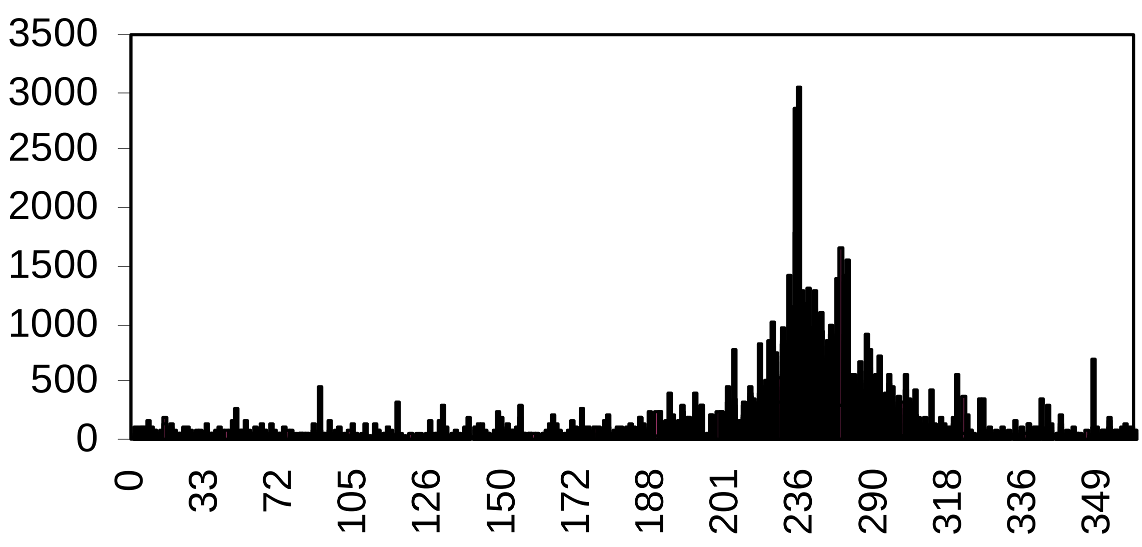


Figure 2: Ambient 5-Minute Mercury Concentration versus Wind Direction, August/September



Quality Control

Quality control procedures for this study included four type of checks of the Tekran mercury analyzer and the data from that analyzer. The four types of checks include:

- A review of the daily calibration reports.
- Periodic independent verification of the calibration using an external mercury source.
- A review of the analyzer desorption flags.
- Comparison of the two analyzer channels for consistency.

A review found all of the data collected between 4/8/02 and 5/16/02 to be of questionable quality. The data showed a number of problems, including the failure of independent mercury standards to verify the daily calibrations, a noticeable difference in the response of the two trapping columns, and a trend of generally decreasing response factors. In addition, the large number of overloads prevented a measurement of a peak mercury concentration, and raised questions of instrument carry over between samples.

Shortly after the initial monitoring period was complete in May, a thorough check of the instrument revealed that one of the mercury traps was depleted and that the analyzer lamp required replacement. These problems would contribute significantly to the calibration and response problems encountered. This maintenance was completed before the instrument was returned to the Vulcan site in August. The problem of instrumental overload was dealt with by decreasing the sample volume from 7.5 to 2.5 liters collected during the 5-minute sampling period.

Missing data between 4/7/02 and 5/16/02 and between 8/16/02 and 9/27/02 is listed in Table Q-1. Not included in Table Q-1 is the time off-line for daily calibrations. The calibration procedure requires the analyzer to be off-line for 40 minutes for each day, resulting in a loss of 2.8% of the daily data.

Table Q-1: Missing Data Periods

Missing Period	Ambient Periods Invalidated	Reasons for Invalidation
4/12/02	15	Verification check
4/18/02	2	Power blip caused the analyzer to restart and run a cleaning cycle on each trap.
4/19/02 09:50 to 4/26/02 12:20	Missing	Analyzer returned to Madison for repairs (trap cleaning) and then returned to site.
8/16/02	9	Startup Calibration
9/08/02	3	Power Blip
9/20/02	13	Verification Check

A final review of the data shows that between 4/8/02 10:40 and 5/16/10 08:30 a total of 8591 / 10918 valid measurements were collected. This is a completeness of 78.7% (this number includes the daily loss of 2.8% for calibrations). When examined on an hourly basis this translated to 701 hours of valid data, out of a potential 909.8 hours, yielding a completeness of 77.0%. This based on a requirement of 75% data capture for the hour.

Review of the data collected between 8/16/02 13:30 and 9/27/02 11:15 shows a total of 11735 / 12069 valid measurements collected. This is a completeness of 97.2%. When examined on an hourly basis, this translates to a total of 960 hours based on a requirement of 75% hourly data capture. With a potential total of 1005 hours of data, this indicates an hourly completeness of 95.5%.

Daily Calibration Reports.

Daily calibrations of the analyzer were automatically conducted at 01:00. The calibration consists of three sample runs on each channel of the analyzer. Runs include a trap cleaning, a zero gas, and a span gas. Following the calibration the instrument prints a report that includes the instrument response factor for each sampling trap. The response factor is then used for the calculation of all results until the next calibration cycle. After the calibration and prior to the start of ambient sampling the analyzer performs a second cleaning run on each trap.

Parameters examined on the calibrations were the clean and zero values, and the span and calculated response factor. A summary of these parameters is show in Table Q-2 and Q-3. The first table summarizes the area count of all Clean and Zero cycles during the project for each analysis channel. Ideally, these values will be zero. Non-zero values are indicators of mercury carryover on the sampling traps, and can be expected for cleaning cycles which interrupt a sampling run. In addition to reporting the range of values observed, the number of zero and non-zero values are quantified. Note that more of these parameters were non-zero during the initial monitoring period. The high values observed, especially during the Zero cycles, were among the indicators of a less than optimum instrument.

Table Q-2: Calibration Parameters, Cleans and Zeros

	April/May Monitoring Period				August/September Monitoring Period			
	CLEANS		ZEROS		CLEANS		ZEROS	
	Channel A	Channel B	Channel A	Channel B	Channel A	Channel B	Channel A	Channel B
Mean	11563	120086	45568	43611	50807	59351	110	160
Min	0	0	0	0	0	0	0	0
Max	370667	4640263	755185	771104	2996344	3613250	4828	4896
Count = 0	61	47	21	22	82	76	43	42
Count >0	16	30	13	12	9	14	1	2
Count >10000	10	23	8	7	6	4	0	0
Count All	77	77	34	34	91	90	44	44

Table Q-3 presents the Span and Response Factor values. During the initial monitoring period, the mean values for the span and the response factor, show the "B" column to have consistently lower response. A graphical time series display of these response factors is shown in Figure 3. The graph also shows that the "B" column has a lower response than the "A" column. While the scale of the graph makes this difficult to see, close examination reveals a general trend of decreasing response factors across the April/May monitoring period. All of these symptoms are consistent with trap and lamp problems, and aided directly in diagnosing the problems.

The Span and Response Factor values from the August/September monitoring period are also presented in Table Q-3, and shown graphically in Figure 4. Note that the values have almost identical averages and ranges, with a significantly lower standard deviation between the daily values. This is direct evidence that the instrument was performing optimally during the second monitoring period. Note that the scale of Figure 4 is significantly limited with respect to the scale in Figure 3.

Table Q-3: Calibration Parameters, Spans and Response Factors

	April/May Monitoring Period				August/September Monitoring Period			
	SPANS		RESPONSE FACTORS		SPANS		RESPONSE FACTORS	
	Channel A	Channel B	Channel A	Channel B	Channel A	Channel B	Channel A	Channel B
Mean	464741	416336	3084573	2743847	310659	310354	2286133	2283524
Min	366654	331514	2621164	834805	281875	280708	2039366	2030418
Max	1148140	884504	3984873	3314524	326429	325569	2403040	2396709
Stdev	31.9%	27.5%	8.0%	14.4%	2.5%	2.5%	2.6%	2.6%
Count	34	34	34	34	44	44	44	44

Figure 3: April/May Response Factors

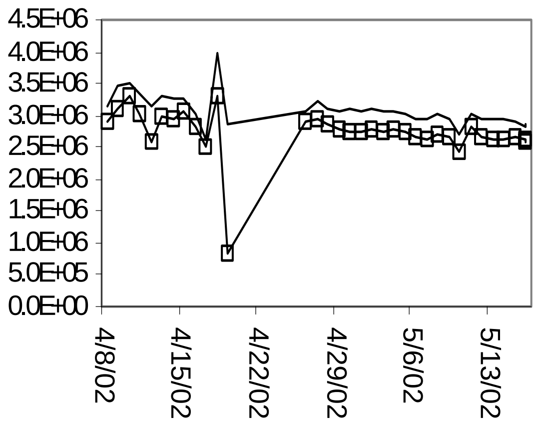
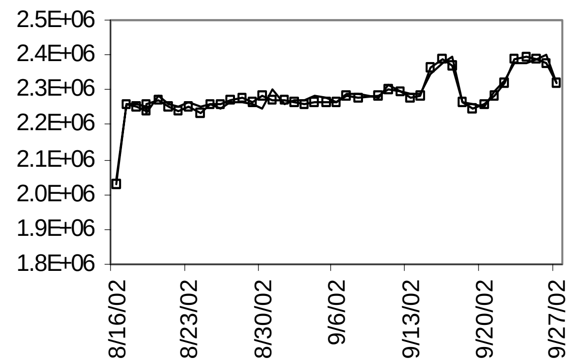


Figure 4: August/September Response Factors



Verifications

The calibration verification is periodically performed to ensure that the analyzer internal calibration is accurate. The procedure is described in the memorandum "Mercury Calibration Verifications". Three verification were performed over the course of the project testing both the "A" and "B" columns at two concentration levels (low and high). Results are summarized below in Table Q-4. Note the high rate of verification failures during the initial portion of the project. The verification performed during the second portion of the project showed no problems.

Table Q-4: Calibration Verification Summary

Date	Column	Expected. Conc. (ng/M3)	Final Conc. (ng/M3)	Recent Recovery	Pass/ Fail
04/12/02	A	52.09	67.24	129.1%	N
04/12/02	B	50.81	71.13	140.0%	N
04/12/02	A	494.50	608.80	123.1%	N
04/12/02	B	502.52	780.93	155.4%	N
04/12/02	A	43.23	193.06	446.6%	N
04/12/02	B	42.83	532.15	1242.3%	N
04/12/02	A	46.64	271.92	583.0%	N
05/16/02	B	34.88	37.00	106.1%	Y
05/16/02	B	335.28	423.31	126.3%	N
05/16/02	A	32.88	35.62	108.3%	Y
05/16/02	A	318.18	367.61	115.5%	Y
05/16/02	B	303.46	379.68	125.1%	N
09/20/02	B	134.86	142.70	105.8%	Y
09/20/02	A	99.60	108.90	109.3%	Y
09/20/02	B	1434.53	1652.28	115.2%	Y
09/20/02	A	936.68	1071.84	114.4%	Y

Data Qualifiers

Each measurement made by the Tekran instrument includes a qualifier called the “desorption flag”. The desorption flag notes any irregularities in the operation of the analyzer during the analysis cycle. Most measurements are assigned an “OK” code. Other significant code reported in the study were “NP”, “M2”, and “OL”. Table Q-5 summarizes the codes assigned to the ambient data in this project.

Table Q-5: Desorption Flag Summary, April/May Monitoring Period

Assigned Code	**Number of Measurements**	**Meaning**	**Effect on Data**
NP	2 / 12	No peak detected. This is acceptable for cleaning and zero gas runs. A NP designation for an ambient sample is an indication of a problem.	See discussion under Evaluation of Unexpectedly Low Values
M2	35 / 23	Multiple peaks detected. This can be an indication of a noisy baseline or shoulder peak.	The data was reviewed and determined to be acceptable. Effects were minimal and occurred with no discernible pattern
OL	68 / 0	Overloaded trap. These peak occur when detector signal exceeds 5 mV.	April/May Overloads at 747 to 2638 ng/M3. Aug/Sep Concentrations to 3047 ng/m^3 .

Channel Consistency

The final data examined here is the channel consistency. The Tekran analyzer uses two gold traps that sample alternately. While one trap is sampling air, the alternate trap is undergoing desorption and analysis. This arrangement allows continuous sampling of the ambient air. While each trap collects independent samples for analysis, the daily average will summarize 140 measurements on each channel and these average values should be similar. We examined the daily averages for all sampling days of the project. The results shown in Figures 5 and 6 show very similar averages on each channel on most days. Some big differences are noted on 4/17, 4/19, 4/29, and 5/9. Note that the channels are indistinguishable during the second monitoring period.

Figure 5: Daily Channel Average, April/May

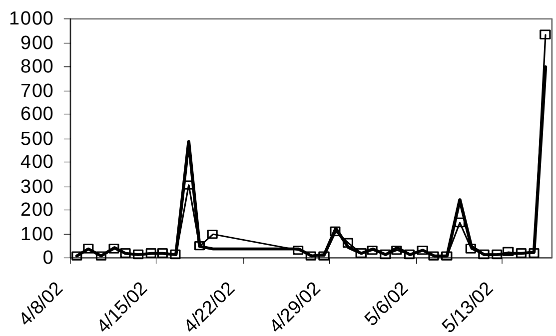
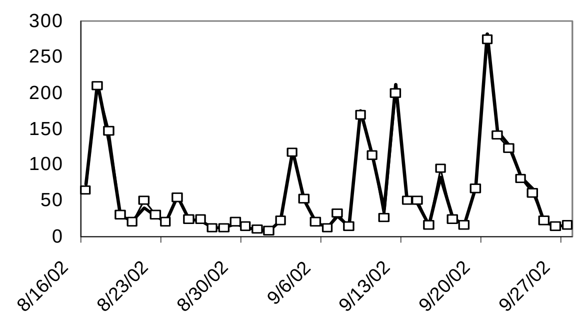


Figure 6: Daily Channel Average, August/September



Evaluation of Unexpectedly Low Values

There is a generally recognized global background concentration of mercury in the atmosphere of about 1.5 ng/m^3 . Concentrations below this level are immediately suspect, as they may be indicators of instrument malfunction. The theoretical instrument detection limit for the sampling conditions used during April and May is 0.1 ng/m^3. Sampling conditions during August and September lead to a theoretical detection limit of 0.3 ng/m^3.

A total of 33 values during the monitoring near Vulcan were observed below 1.5 ng/m^3 . These values are reported in Table Q-6 below. Pertinent parameters include the date and time of the observation, the channel which returned the low values, and the value itself.

Table Q-6: Suspect Low Values

Date/Time	Channel	ng/m3	Date/Time	Channel	ng/m3	Date/Time	Channel	ng/m3
5/9/02 18:25	B	1.483	**5/9/02 23:15**	B	0.42	**8/17/02 23:45**	B	0
5/9/02 18:35	B	1.174	**5/9/02 23:25**	B	0.762	**8/17/02 23:50**	A	0
5/9/02 18:45	B	0.772	**5/9/02 23:45**	B	0.431	**8/17/02 23:55**	B	0
5/9/02 19:35	B	1.466	**5/10/02 0:35**	B	0.752	**9/3/02 18:50**	B	0
5/9/02 19:45	B	0.379	**5/10/02 2:15**	B	0.675	**9/3/02 18:55**	A	0
5/9/02 21:35	B	0.304	**5/10/02 2:25**	B	0.567	**9/3/02 19:00**	B	0
5/9/02 21:55	B	1.413	**5/10/02 2:35**	B	0	**9/3/02 19:05**	A	0
5/9/02 22:05	B	1.068	**5/10/02 2:45**	B	0.067	**9/3/02 19:10**	B	0
5/9/02 22:15	B	0.982	**5/10/02 2:55**	B	0	**9/21/02 17:55**	B	0
5/9/02 22:55	B	0.166	**5/10/02 3:45**	B	1.1	**9/21/02 18:00**	A	0
5/9/02 23:05	B	0.78	**8/17/02 23:40**	A	0	**9/22/02 18:55**	B	0

Note that all suspect low values from the April/May monitoring period occurred on 5/9 and 5/10/02, and that all values were obtained on the B channel. Note that the daily channel averages reveal an observable difference between the two channels on 5/9/02. Observed channel A values during the same time frames as the low channel B values average 12.0 ng/m^3 , while those of channel B average 0.7 ng.m^3 . This combination of factors decreases the likelihood that the observed low values from April and May have any actual physical meaning.

The low values observed during the August and September monitoring period are not as easy to explain away. Unlike the earlier observations, the later values are all 0, and split equally between the channels. In general, the values are obtained continuously over short periods of time. Examining results surrounding each of the periods of zero values, one observes high concentration values (greater than 100 ng/m^3) within a short time frame on either side of the suspect values, with radically decreasing values leading to and increasing values following the actual suspect values. There are no clear indications of instrument failure, although there are possible instrumental causes.

Thus, the suspect values observed during the August/September monitoring period may be potentially real, or at least indicative of unusually low ambient mercury concentrations. This, in turn, requires exploration of possible reasons for zero values. It is known that the elemental form of mercury is relatively stable in the atmosphere, with its long residence time helping lead to the global background average concentration.

While the detailed chemistry of mercury cycling in the atmosphere is not fully understood, another form of the element, reactive gaseous mercury (RGM), is highly reactive and easily washed out of the atmosphere. Normally, RGM is present as only a small percentage of the total gaseous mercury. EPA estimates of reactive and elemental mercury emissions from chlor-alkali plants indicate that a significant percentage of the emissions could be in the reactive form. If this is indeed the case, then it is possible that the proper conditions (mostly RGM emissions at a particular point in time, combined with rain to wash the mercury out of the atmosphere) could lead to the observed results.

At this point, there is no real way to tell whether or not the observed suspect values represent actual environmental conditions. Further study at this location, including sampling for reactive gaseous mercury, would be required to provide more information.

Conclusions

The initial monitoring period in April and May did not meet basic quality control criteria for a successful monitoring project, and as such the data collected throughout the period is suspect. The results are not simply disregarded for several reasons. First of these is that the observations made helped define the instrumental parameters necessary for successful monitoring at this location. Next, while the results are not as strictly quantitative as desirable, they do clearly indicate the effect operations at Vulcan have on the immediate ambient environment. Finally, and in spite of the difficulties presented during the initial period, observed results are not greatly different between the two different periods.

Data quality during the August/September monitoring period easily matched and exceeded standard quality control requirements, lending high confidence to the results obtained. Observed concentrations are significant enough to warrant further monitoring in the future. The unexpected zero values indicate that there may be significant reactive gaseous mercury present in the emissions. RGM has an especially important role in the global mercury cycle, as it is this form which readily washes out of the atmosphere and gets absorbed in the biosphere.

- We strongly recommend that additional monitoring be conducted near the facility. In addition to the goal of collecting high quality data, methods for the collection of RGM samples should be investigated and deployed at the same time.

Appendix A: Verfication Protocols

DATE: 4/15/02 FILE REF:

TO: Air Toxics Monitoring Files

FROM: Mark K. Allen – AM/7

SUBJECT: Tekran 2537A Mercury Analyzer - External Accuracy Check

Purpose: To challenge the Tekran analyzer with an external mercury source and demonstrate the analyzer accurate. The goal is to show mercury recovery between 80% and 120%.

Method: The analyzer air inlet is switched to the compressed zero air. The analyzer is allowed to cycle to collect a trap blanks. Following the blank a spike sample is created. The vapor phase mercury above an aliqout of liquid mercury is collected in a syringe and then injected into the analyzer during the sample collection phase. The mercury standard is collected on one of the gold traps along with the air sample. A second blank is collected after the spike. The analysis is by a standard addition technique with the average blank value subtracted from the spiked value.

Mercury Source: The Tekran 2505 Mercury Vapor Calibration Unit contains a mercury reservoir in a temperature controlled block. A septum covers the mercury reservoir and allows aliqouts of vapor phase mercury to be withdrawn in a gas tight syringe. The mircoprocessor in the calibration unit will also calculate the mass of mercury injected onto the trap.

Making an injection: Injections are made with a manual gas tight syringe. The septum wrench is placed on the sampling port to keep the syringe in the correct position for sample collection. The syring is filled in the following manner.

- Insert the syringe into the sampling port
- Purge the syringe by first withdrawing the plunger and then reinjecting the plunger.
- Quickly repeat the purge 6 to 10 times.
- Withdraw the plunger to collect the desired volume of mercury vapor.
- Note the reservoir temperature and the volume of the vapor aliquot (or alternatively use the mass calculation feature of the calibrator to calculate the mass of mercury)
- Remove the syringe and quickly inject the mercury sample into the 2537A analyzer. Samples should be injected during the first 100 seconds of sample collection.

Record the measured mercury on the test trap. Also record the background as the measured mercury blank before and after the spiked sample. The background should be the average of the measured mercury before and after the test trap is spiked.

Calculations: The concentration of mercury vapor in the reservoir is a function of the temperature. The concentration can be determined using equation 1

Eq. 1 $$[Hg(o)] = (A/T)^* 10 \wedge -(-B+(C/T))$$

Where
[Hg(o)] is the concentration of elemental mercury in pg/ul
T = temperature in C
A = 3216523
B = 8.13446
C = 3240.872

When the concentration of the mercury is known the amount injected on the trap can be determined by Equation 2.

Eq. 2. pg Hg(o) = [Hg(o)] * ul

The expected concentration is determined by Equation 3

Eq. 3. [Hg(o)] (ng/M3)= Pg Hg(o) / Sampled air volume (L)

To calculate the recovery of mercury

Eq. 4 % Recovery = (Measured – Background) / Expected

Goal: **The goal of this test is to get a percent recovery of 80% to 120%. The analyzer passes the calibration verification if the mercury recovery is calculated within this range.**

Appendix B: Hourly Average Mercury Values, April 2002

All concentration in ng/M3.												
	Hour											
Day	0	1	2	3	4	5	6	7	8	9	10	11
04/08/02												
04/09/02	2.8	(2.3)	2.2	2.2	2.3	2.7	3.9	3.5	3.7	4.9	9.0	20.1
04/10/02	20.2	(11.3)	11.0	5.0	4.7	6.4	11.2	15.5	17.0	11.6	13.6	14.9
04/11/02	3.5	(4.6)	3.7	3.9	4.0	4.6	5.1	5.2	17.6	15.7	11.9	15.9
04/12/02	17.9	(13.9)	11.7	11.4	10.4	10.9	14.4	14.0	17.7	22.1	(18.5)	(23.5)
04/13/02	11.7	(13.6)	14.3	11.8	11.0	11.7	31.9	31.2	18.7	16.5	15.2	36.2
04/14/02	8.0	(8.5)	7.2	6.5	5.2	4.2	6.0	8.0	7.9	7.0	17.1	35.4
04/15/02	55.9	(53.3)	27.2	20.0	20.4	18.5	29.2	21.6	15.8	12.2	10.4	11.4
04/16/02	10.0	(11.2)	9.7	9.0	9.2	8.1	8.7	8.4	8.7	8.4	10.0	10.9
04/17/02	16.3	(21.5)	97.9	245.3	193.6	**722.7**	**1137.0**	**1536.8**	**863.9**	**737.5**	573.0	503.3
04/18/02	40.6	(30.1)	11.3	9.1	15.8	25.1	35.5	55.8	39.9	23.2	59.5	56.4
04/19/02	64.0	(50.7)	46.3	64.6	66.0	72.4	97.6	67.6	64.4	(39.1)		
04/27/02	4.8	(4.1)	4.2	3.6	3.3	3.6	5.2	7.7	6.2	4.6	3.8	3.5
04/28/02	2.4	(2.8)	2.5	2.6	2.9	3.1	4.3	4.4	7.2	8.2	6.3	5.4
04/29/02	27.8	(10.2)	8.8	4.6	7.2	7.0	11.9	63.7	215.2	217.9	145.4	158.7
04/30/02	5.1	(5.7)	5.7	15.9	24.3	29.5	45.8	17.6	24.0	15.0	85.5	17.0
Day	12	13	14	15	16	17	18	19	20	21	22	23
04/08/02	7.1	30.7	6.1	5.8	5.8	5.1	4.0	3.2	2.8	3.0	3.2	3.3
04/09/02	92.8	198.5	52.4	140.7	132.7	71.8	34.9	33.4	37.0	21.6	26.4	24.4
04/10/02	9.9	8.7	9.6	7.2	5.9	5.3	5.7	5.0	4.3	4.3	3.9	3.2
04/11/02	15.4	9.8	8.6	8.5	60.4	270.5	117.7	124.2	86.9	31.6	85.1	21.1
04/12/02	54.1	36.7	26.4	13.6	10.3	10.6	12.8	16.0	19.0	15.0	15.6	14.3
04/13/02	20.1	14.0	13.9	8.3	9.3	8.1	8.2	7.8	6.4	5.7	5.5	6.6
04/14/02	19.6	11.4	10.7	13.0	13.8	14.4	26.9	28.9	43.3	51.7	53.1	43.9
04/15/02	11.1	11.6	14.0	13.9	12.1	8.7	9.2	10.6	9.9	7.4	7.8	9.1
04/16/02	11.5	12.2	10.7	10.0	10.7	10.0	9.1	10.2	9.0	7.5	19.8	130.9
04/17/02	481.6	552.0	439.9	334.2	269.8	170.5	38.2	55.7	78.8	70.3	57.9	47.9
04/18/02	33.6	31.1	27.5	16.7	16.2	14.0	77.4	**100.8**	263.4	52.6	84.1	32.6
04/26/02	(125.1)	85.7	55.9	129.9	16.8	9.7	5.3	5.2	9.7	5.0	5.0	5.1
04/27/02	5.4	7.7	6.1	5.9	3.6	3.0	2.8	2.8	2.8	2.7	2.5	2.4
04/28/02	5.3	4.4	4.5	3.7	3.3	3.3	3.9	3.3	6.3	35.4	45.6	31.2
04/29/02	231.7	131.3	379.7	350.8	232.6	164.4	182.6	16.2	5.8	13.7	109.3	5.5
04/30/02	218.9	198.5	194.6	216.3	78.7	9.5	11.0	12.5	9.6	6.2	5.4	13.1

Bold values indicate at least one of the measurement in the average was overloaded and therefore the value is a minimum.
Bracketed values indicate the average was calculated on less than 75% data capture (<9measurements/hour)

Appendix C: Hourly Average Mercury Values, May 2002

All concentration in ng/M3.												
	Hour											
Day	0	1	2	3	4	5	6	7	8	9	10	11
05/01/02	8.1	(5.2)	5.1	5.4	6.7	11.0	19.0	22.6	25.5	24.2	18.6	18.1
05/02/02	8.5	(25.6)	42.3	4.6	4.8	14.2	17.3	24.5	23.1	16.7	19.8	27.0
05/03/02	4.0	(5.0)	3.1	3.7	6.1	16.6	14.7	13.5	12.4	14.3	15.6	13.4
05/04/02	4.5	(5.3)	4.9	4.7	4.7	6.6	10.5	12.7	12.8	13.5	16.3	15.7
05/05/02	9.2	(16.1)	10.6	8.6	8.4	27.8	34.7	24.6	24.5	21.0	23.3	21.1
05/06/02	7.0	(6.5)	5.8	6.7	9.2	16.3	11.3	17.8	22.5	30.6	50.6	66.4
05/07/02	5.3	(5.5)	4.7	4.2	4.1	6.3	11.7	14.4	16.2	17.4	14.6	16.4
05/08/02	2.7	(2.7)	2.4	2.4	2.5	2.9	3.6	4.3	8.8	11.0	13.6	10.8
05/09/02	4.0	(4.2)	4.7	5.6	35.3	22.5	108.3	210.2	**408.6**	**627.2**	**912.2**	**900.2**
05/10/02	6.2	(105.7)	3.7	9.0	26.5	32.5	35.0	27.9	29.0	58.6	140.7	66.6
05/11/02	17.6	(11.8)	5.6	5.0	6.4	9.0	9.4	7.6	8.1	7.5	13.5	14.5
05/12/02	4.5	(5.3)	4.4	4.2	4.6	5.7	8.8	16.4	24.7	25.6	33.2	29.2
05/13/02	4.5	(4.6)	4.2	4.6	6.5	30.6	32.9	33.3	17.7	12.9	18.4	24.1
05/14/02	6.1	(7.4)	8.8	16.9	11.4	13.0	23.8	40.0	21.0	18.0	18.7	22.8
05/15/02	11.7	(14.1)	9.5	7.1	7.0	17.9	18.6	25.7	21.7	23.4	23.1	20.1
05/16/02	**146.8**	**(2253.2)**	**2102.9**	**1268.0**	**843.6**	**570.8**	29.2	(19.2)	(29.9)			
Day	12	13	14	15	16	17	18	19	20	21	22	23
05/01/02	21.7	15.8	28.2	20.3	18.0	34.2	22.2	12.3	9.8	21.2	31.3	24.4
05/02/02	101.1	188.8	61.4	46.2	70.2	55.2	5.1	3.0	3.3	3.7	5.1	5.3
05/03/02	17.7	31.9	26.5	9.5	11.3	8.3	4.5	5.7	5.5	6.4	7.7	7.2
05/04/02	70.1	87.8	110.9	86.3	89.1	238.1	12.2	14.8	15.0	9.9	7.0	5.7
05/05/02	19.1	18.2	18.3	14.5	10.6	8.4	7.3	7.6	7.3	7.3	6.4	8.1
05/06/02	57.8	126.5	53.5	133.3	55.7	31.6	21.8	15.4	9.6	8.9	7.1	6.5
05/07/02	12.4	11.1	10.6	9.0	8.5	5.9	4.4	3.6	3.7	3.6	3.0	2.6
05/08/02	11.0	12.6	12.6	11.1	7.4	5.9	4.4	3.8	3.8	4.3	4.4	4.0
05/09/02	**729.5**	134.0	105.5	85.5	88.4	66.3	18.1	12.2	17.5	15.9	2.6	3.9
05/10/02	67.1	44.3	49.5	38.9	100.7	33.7	10.0	28.3	29.4	41.8	37.1	27.0
05/11/02	26.1	22.4	23.9	17.0	8.5	9.2	8.0	6.2	6.0	5.1	4.8	4.9
05/12/02	23.5	18.1	21.5	14.9	8.5	6.3	4.9	4.5	5.1	4.5	4.6	4.6
05/13/02	20.9	9.2	83.2	39.3	108.3	37.2	6.7	10.4	10.0	7.0	7.0	6.9
05/14/02	23.5	33.9	23.8	27.3	12.5	7.7	6.3	11.2	9.8	12.0	20.0	25.8
05/15/02	14.9	17.9	22.3	41.8	24.8	20.5	23.4	9.3	10.1	96.8	28.8	11.9

Bold values indicate at least one of the measurement in the average was overloaded and therefore the value is a minimum.
Bracketed values indicate the average was calculated on less than 75% data capture (<9measurements/hour)

Appendix D: Hourly Average Mercury Values, August 2002

All concentration in ng/M3.

	Hour											
Date	0	1	2	3	4	5	6	7	8	9	10	11
17-Aug-02	5.3	(5.7)	7.7	29.9	12.4	7.7	17.1	130.0	501.8	568.5	727.4	312.0
18-Aug-02	63.7	(24.0)	36.2	70.4	45.1	63.5	250.0	172.1	182.7	228.8	324.4	223.1
19-Aug-02	15.9	(21.2)	13.2	10.5	9.1	33.5	97.6	61.4	51.8	42.6	64.6	53.0
20-Aug-02	6.7	(6.1)	5.8	5.1	6.6	22.0	63.8	55.6	43.1	35.7	41.3	40.1
21-Aug-02	4.3	(7.9)	5.5	5.0	4.9	6.6	6.8	13.3	18.2	28.9	30.1	24.9
22-Aug-02	115.0	(58.9)	15.8	11.5	11.5	12.8	16.6	46.1	62.7	44.4	34.9	40.5
23-Aug-02	6.1	(9.1)	10.2	6.6	6.7	6.9	10.3	20.1	36.7	26.0	25.6	43.7
24-Aug-02	66.4	(15.3)	13.1	10.0	5.7	8.2	17.2	36.6	75.4	86.8	98.8	228.7
25-Aug-02	8.4	(10.7)	9.1	9.8	8.6	17.0	47.5	48.6	47.7	40.9	34.4	31.9
26-Aug-02	10.5	(8.3)	7.6	10.7	7.2	10.8	34.4	39.2	36.2	33.0	66.1	43.5
27-Aug-02	5.6	(6.2)	5.0	5.2	4.6	6.8	17.1	21.2	21.7	23.4	24.5	22.7
28-Aug-02	4.7	(5.0)	4.4	4.5	5.1	6.4	12.1	16.8	18.5	23.2	27.0	20.8
29-Aug-02	10.4	(9.9)	8.0	8.2	6.4	10.5	22.2	18.4	17.4	19.0	17.3	65.1
30-Aug-02	9.6	(5.2)	5.9	5.3	6.5	6.2	20.6	15.9	16.2	17.8	17.4	16.4
31-Aug-02	5.2	(17.2)	7.5	10.0	5.3	9.6	14.3	12.2	12.9	13.7	14.0	13.5
Date	12	13	14	15	16	17	18	19	20	21	22	23
16-Aug-02		(487.5)	364.8	(70.4)	21.7	28.7	38.4	14.0	8.7	7.8	5.6	6.5
17-Aug-02	501.3	453.5	124.1	158.3	150.3	226.6	120.4	232.9	305.5	185.5	127.5	33.9
18-Aug-02	399.4	310.5	420.2	94.1	67.5	21.9	71.4	63.8	41.1	28.8	66.1	23.3
19-Aug-02	(35.2)	26.7	23.9	19.8	16.7	12.7	16.6	23.6	22.8	15.5	10.4	10.3
20-Aug-02	26.7	34.3	26.3	20.5	16.1	12.3	8.4	4.8	4.1	4.1	5.5	4.2
21-Aug-02	19.1	30.8	28.4	25.2	13.0	10.2	10.6	16.3	56.9	258.5	270.2	168.3
22-Aug-02	31.8	39.4	37.4	33.7	26.7	15.9	10.0	7.9	8.2	7.1	6.6	15.1
23-Aug-02	33.3	28.1	38.9	36.5	24.6	18.7	9.7	7.5	7.9	12.2	15.1	21.2
24-Aug-02	75.2	136.2	208.5	44.7	41.5	27.8	25.8	25.3	18.9	13.0	13.5	33.7
25-Aug-02	32.2	28.0	32.6	41.4	21.7	13.3	35.6	19.9	15.4	11.3	9.7	9.5
26-Aug-02	29.9	24.3	25.7	27.3	18.0	13.1	29.9	22.4	12.3	12.0	11.5	6.5
27-Aug-02	22.1	21.0	17.5	15.9	13.8	12.4	8.1	6.1	5.9	5.5	4.9	4.4
28-Aug-02	18.6	16.9	13.6	11.3	9.0	8.4	18.8	15.3	7.3	11.2	6.1	7.4
29-Aug-02	49.7	46.9	17.0	14.1	14.2	11.8	22.7	16.0	13.1	9.9	7.6	9.9
30-Aug-02	36.0	26.3	18.7	10.7	8.5	8.8	22.7	14.8	8.4	7.6	4.6	4.7
31-Aug-02	10.7	10.6	9.2	8.1	6.3	5.5	8.6	15.7	11.0	10.1	5.1	4.9

No measurements during this period were overloaded.
Bracketed values indicate the average was calculated on less than 75% data capture (<9measurements/hour)

Appendix E: Hourly Average Mercury Values, September 2002 (Hours 0 – 11)

All concentration in ng/M3.

Date	0	1	2	3	4	5	6	7	8	9	10	11
01-Sep-02	7.1	(4.5)	5.8	6.1	6.2	6.1	6.8	9.3	12.4	14.4	14.5	12.8
02-Sep-02	4.6	(9.7)	28.4	7.4	10.0	6.3	7.7	11.4	16.5	16.2	18.9	17.5
03-Sep-02	175.4	(232.6)	129.9	72.0	72.8	60.4	36.5	132.0	182.2	250.3	317.0	198.9
04-Sep-02	14.8	(20.3)	36.4	13.8	11.4	21.6	94.6	123.2	85.6	49.6	49.2	145.6
05-Sep-02	15.6	(12.4)	12.7	10.9	10.7	11.1	26.7	45.8	48.5	43.7	33.1	30.4
06-Sep-02	8.9	(8.6)	6.4	5.0	4.0	6.2	9.7	14.0	14.1	15.6	24.5	22.3
07-Sep-02	6.7	(5.3)	7.0	4.5	4.5	6.1	11.2	17.5	24.7	193.0	145.9	49.2
08-Sep-02	11.6	(11.1)	9.5	14.0	7.5	9.9	18.2	22.9	23.5	24.2	22.0	21.2
09-Sep-02	10.9	(12.4)	8.9	7.3	6.7	10.4	15.8	23.9	218.6	381.1	443.9	393.8
10-Sep-02	17.0	(37.8)	13.7	7.3	44.3	506.3	746.6	837.8	143.9	37.8	37.1	41.3
11-Sep-02	4.9	(4.5)	4.7	6.9	4.6	7.3	29.8	95.1	27.6	84.2	19.5	17.7
12-Sep-02	5.9	(5.4)	7.4	9.5	9.5	10.8	46.9	28.3	173.2	505.6	554.2	383.3
13-Sep-02	49.5	(60.3)	23.6	40.1	36.4	30.0	80.9	67.1	66.5	129.3	154.5	143.2
14-Sep-02	13.3	(12.4)	49.7	195.5	30.4	30.3	16.6	63.0	29.8	33.5	32.8	55.2
15-Sep-02	4.3	(3.1)	2.8	3.7	2.8	4.4	24.7	43.3	40.6	33.3	23.7	21.1
16-Sep-02	9.6	(9.5)	6.6	30.5	24.8	17.7	47.1	39.0	88.3	139.3	123.9	457.7
17-Sep-02	14.5	(13.8)	11.4	11.1	9.4	12.3	65.3	68.6	64.0	52.0	36.8	29.7
18-Sep-02	10.0	(6.2)	6.0	6.7	6.4	6.1	10.9	13.3	16.9	33.2	36.6	40.2
19-Sep-02	5.8	(7.1)	17.9	7.0	4.8	6.5	8.9	10.8	31.2	36.2	48.8	26.4
20-Sep-02	24.9	(18.4)	11.0	9.5	7.8	8.7	14.5	45.0	104.1	29.0	34.9	465.3
21-Sep-02	61.1	(451.3)	82.7	41.0	56.1	27.8	93.1	228.3	196.4	199.1	184.3	113.4
22-Sep-02	139.3	(123.3)	200.8	143.4	81.0	80.2	243.2	182.1	243.9	345.1	129.1	128.6
23-Sep-02	31.9	(33.8)	60.8	28.6	14.0	12.1	45.6	86.5	83.1	38.4	34.7	38.4
24-Sep-02	22.8	(158.3)	126.5	131.7	90.8	56.1	61.0	99.9	146.4	145.5	64.3	92.8
25-Sep-02	17.6	(14.0)	8.3	8.6	6.0	5.6	7.1	8.9	31.4	73.1	67.6	42.5
26-Sep-02	8.0	(9.0)	6.4	6.3	5.7	6.6	12.7	35.7	51.3	28.8	24.5	31.1
27-Sep-02	5.5	(6.2)	4.7	4.4	5.2	6.1	7.1	13.7	23.8	37.7	74.0	

No measurements during this period were overloaded.
Bracketed values indicate the average was calculated on less than 75% data capture (<9measurements/hour)

Appendix E: Hourly Average Mercury Values, September 2002 (Hours 12 – 23)

All concentration in ng/M3.												
Date	12	13	14	15	16	17	18	19	20	21	22	23
01-Sep-02	11.2	10.3	8.9	7.8	6.8	5.6	4.8	3.9	3.8	3.8	6.4	5.5
02-Sep-02	24.6	23.9	15.1	12.7	12.2	14.2	9.8	5.6	4.5	27.4	95.5	142.1
03-Sep-02	117.6	90.6	175.5	95.3	130.5	108.2	45.3	76.0	80.7	50.3	35.6	30.3
04-Sep-02	167.2	49.7	52.1	33.3	31.1	51.1	56.1	29.3	22.9	16.0	14.8	15.4
05-Sep-02	27.7	24.6	20.6	16.0	11.9	8.7	9.1	14.2	11.3	11.6	9.6	9.8
06-Sep-02	22.7	23.6	19.1	16.4	13.9	12.3	7.6	10.3	7.3	11.3	6.3	6.7
07-Sep-02	39.5	35.3	30.3	23.4	19.0	14.6	12.9	18.9	16.7	11.1	14.7	9.8
08-Sep-02	18.8	16.5	17.1	15.8	12.9	10.5	11.3	10.2	7.4	6.7	11.2	18.4
09-Sep-02	635.5	449.9	346.8	356.3	281.6	198.0	82.1	44.6	35.5	32.7	32.2	15.3
10-Sep-02	43.0	25.3	19.8	16.5	12.7	8.2	7.4	8.8	6.7	6.1	6.4	9.0
11-Sep-02	23.3	163.2	107.9	71.5	11.1	12.1	16.8	14.0	10.4	8.5	6.6	4.9
12-Sep-02	936.2	430.1	514.3	349.4	214.3	126.6	176.2	106.4	108.7	34.9	29.3	33.1
13-Sep-02	43.2	82.0	38.7	22.8	21.9	16.5	11.8	13.2	11.8	14.6	18.3	21.4
14-Sep-02	206.3	122.7	148.0	36.2	23.0	12.5	10.3	5.6	5.2	5.0	4.3	4.3
15-Sep-02	19.3	19.5	16.5	16.1	11.3	18.4	15.8	10.1	9.3	8.8	10.0	10.0
16-Sep-02	69.7	292.2	146.3	59.9	113.3	73.8	57.0	114.9	81.1	36.0	20.1	18.9
17-Sep-02	26.0	27.7	21.3	18.2	17.6	21.2	17.5	11.0	10.4	13.0	10.7	12.7
18-Sep-02	29.3	30.6	18.6	16.8	22.9	11.7	6.5	6.4	5.4	5.5	6.5	6.6
19-Sep-02	48.7	187.4	26.0	34.2	24.4	12.1	278.2	225.2	238.4	181.2	88.6	33.8
20-Sep-02	972.1	1003.6		684.0	586.5	796.0	599.5	393.7	277.9	95.6	56.5	34.5
21-Sep-02	134.0	203.2	150.6	119.9	173.8	274.8	56.9	83.8	174.8	149.4	88.1	286.6
22-Sep-02	152.2	144.3	105.9	91.6	92.4	28.9	23.7	17.4	79.2	76.4	75.9	64.8
23-Sep-02	75.6	60.2	290.5	489.9	242.1	133.2	49.3	40.1	10.3	7.5	7.3	17.2
24-Sep-02	152.2	34.6	30.3	40.3	15.3	19.9	15.2	14.1	9.5	9.7	23.0	14.0
25-Sep-02	38.6	29.7	25.1	14.5	15.3	13.7	11.5	16.5	20.9	8.7	9.3	8.6
26-Sep-02	28.9	19.4	20.7	13.2	10.0	5.9	4.8	5.1	4.6	4.6	4.2	4.8

No measurements during this period were overloaded.
Bracketed values indicate the average was calculated on less than 75% data capture (<9measurements/hour)

Appendix F: Daily Average Mercury, April and May

Daily Average Mercury Concentrations		
Date	Average ng/M3	Count
04/08/02	(6.7)	141
04/09/02	39.5	281
04/10/02	8.9	281
04/11/02	39.8	281
04/12/02	17.6	266
04/13/02	14.1	281
04/14/02	19.1	281
04/15/02	16.7	281
04/16/02	15.3	281
04/17/02	**394.3**	281
04/18/02	**48.6**	279
04/19/02	(65.7)	106
04/26/02	(32.6)	131
04/27/02	4.3	281
04/28/02	8.6	281
04/29/02	115.1	281
04/30/02	53.9	281
05/01/02	18.2	281
05/02/02	32.5	281
05/03/02	11.2	281
05/04/02	36.6	281
05/05/02	15.1	281
05/06/02	33.1	281
05/07/02	8.4	281
05/08/02	6.5	281
05/09/02	**193**	281
05/10/02	42.2	281
05/11/02	10.7	281
05/12/02	12.2	281
05/13/02	23	281
05/14/02	17.8	281
05/15/02	22	281
05/16/02	**(875.4)**	81

A count of 281 indicates the average included all possible measurements for the day.
Values in brackets indicate the average was calculated on less than 75% data capture (211 measurements)
Bold values indicate the average includes at least one measured value that overloaded the trap. The average is therefore a minimum value.

Appendix G: Daily Average Mercury, August and September

Daily Average Mercury Concentrations

Date	Average ng/m3	Count
16-Aug-02	(68.5)	114
17-Aug-02	211.0	281
18-Aug-02	140.0	281
19-Aug-02	29.6	274
20-Aug-02	21.2	281
21-Aug-02	45.2	281
22-Aug-02	28.7	281
23-Aug-02	19.5	281
24-Aug-02	56.1	281
25-Aug-02	24.7	281
26-Aug-02	22.9	281
27-Aug-02	12.7	281
28-Aug-02	12.4	281
29-Aug-02	18.8	281
30-Aug-02	13.3	281
31-Aug-02	9.9	281
01-Sep-02	7.8	281
02-Sep-02	22.9	281
03-Sep-02	118.1	281
04-Sep-02	51.0	281
05-Sep-02	20.0	281
06-Sep-02	12.5	281
07-Sep-02	30.7	281
08-Sep-02	14.7	278
09-Sep-02	172.4	281
10-Sep-02	111.9	281
11-Sep-02	32.2	281
12-Sep-02	204.8	281
13-Sep-02	49.7	281
14-Sep-02	48.6	281
15-Sep-02	15.8	281
16-Sep-02	88.5	281
17-Sep-02	25.1	281
18-Sep-02	15.2	281
19-Sep-02	67.7	281
20-Sep-02	277.8	268
21-Sep-02	143.8	281
22-Sep-02	124.7	281
23-Sep-02	81.6	281
24-Sep-02	63.3	281
25-Sep-02	21.1	281
26-Sep-02	14.8	281
27-Sep-02	(16.3)	123

Values in brackets indicate the average was calculated on less than 75% data capture (211 measurements)